

Taxonomical and Anatomical Identification of a New Species of *Canscora* from South India: A Medicinally Important Genus

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Abstract: To separate of variety of *Canscora diffusa* into a new species by their taxonomical and anatomical characters. Previous studies concluded that *Canscora diffusa* and *Canscora sanjappae* were synonymous. Because *C. sanjappae* has smaller corolla lobes fused at apex and actinomorphic flowers which is common phenomenon in *C. diffusa*. In our present study on *C. racemosa*, we found that both the species were different by the presence of limited branches, yellowish 4-angled stem, persistent corolla, stigma longer than stamens, yellow coloured anisomorphic stamens, usually each dichotomous branch ends in a solitary flower, raceme in nature and gynoeceium longer than stigma style. Anatomical difference between both the species of *Canscora* reflects that *C. racemosa* differs mainly by the presence of trichomes in T.S of stem and leaf sections. Both taxonomical and anatomical studies conclude that the variety of *C. diffusa* differs from *C. diffusa* by various characters. Hence, variety of *C. diffusa* can be treated as a new species and named as *Canscora racemosa* by their raceme type of inflorescence.

Key words: Taxonomical and anatomical identification • *Canscora diffusa* and *Canscora sanjappae* • New species • *Canscora racemosa*

INTRODUCTION

The genus *Canscora* Lam. of the tribe Canscorinae is represented by 9 species in tropical Asia, Africa and Australia, of which 7 species are reported from India. Further floristic exploration of the biodiversity rich Mookambika Wildlife Sanctuary in the later years resulted in two more new species namely *C. sanjappae* Diwakar and R. Kr. Singh [1]. While carrying out floristic survey of Southern Kerala, the authors collected an interesting species of *Canscora racemosa*. On critical analysis, we confirmed as new species by both morphological and anatomical studies.

Description of New Species: Stem 4-angular. Lower leaves 2 x 1.5 cm, elliptic, petiolate; upper ones ovate, sessile, 3-ribbed, glabrous. Cymes terminal; bracts ovate. Flowers many; pedicel 1 cm long, filiform; calyx 6 mm long, wingless, 5-toothed, glabrous; corolla white, 9 mm long, tube cylindrical, lobes lanceolate, acute; two stamens fertile, two sterile. Capsule 5 mm long, linear-oblong [2].

Profusely branched; quadrangular, wings upto 0.3 mm wide; 6 – 48 cm high. Irregular branching pattern. Lower cauline leaves deciduous; leaves coriaceous, glabrous; upper cauline leaves petiolate, elliptic lanceolate, 12 – 39 × 7 – 27 mm, base attenuate to wedge-shaped, apex acute. Lax diffuse paniculate cymes. Flower-Pedicellate; pedicels 1.5 – 15 mm long. Bract- Broadly ovate, 1 – 4 × 0.1 – 1.2 mm.

The genus *Canscora* was first established by Lamarck (1785: 601) to include a single species, *C. perfoliata* Lamarck (1785: 601). The diagnostic characters as given by Lamarck include branched, angular stem, oval-pointed leaves, 2–3-flowered inflorescence, rounded and perfoliate bracts, 4 unequal petals (2 larger and 2 smaller) and 4 unequal stamens.

Subsequently, a few more species were transferred to *Canscora* (viz., *C. heteroclita* (Linnaeus) [4] (= *Gentiana heteroclita* Linnaeus [5], *C. diffusa* (Vahl) [6] (= *Gentiana diffusa* [7], *C. alata* (Roth) [8] (= *Pladera decussata* Roxburgh [9]. [10] divided the genus into three subgenera, namely, subgen. *Canscora* Lamarck

(1785: 601) (as 'Eucanscora'), *Heterocanscora* (Clarke) [10] and *Phyllocyclus* (Kurz) [10]. One more subgenus, viz., subgenus *Pentanthera* [11] was subsequently recognized under this genus. The subgenus *Canscora* and *Heterocanscora* have typical zygomorphic corolla and anisomorphic stamens and belong to the present day circumscription of *Canscora* while subgen. *Phyllocyclus* is treated as a distinct genus and subgenus *Pentanthera* is placed under the synonymy of *Duplipetala*. [12] in his recent classification of the tribe Canscorinae, circumscribed *Canscora* as monophyletic, characterized by zygomorphic corolla and anisomorphic androecium, represented by 9 species and without any infrageneric taxa [2].

C. racemosa differs from *C. diffusa* by raceme type inflorescence, all stamen filaments were similar in size but 1 stamen inserted higher than other 3, solitary flowers, zygomorphic or actinomorphic flowers. An anatomical variation also occurs between both species of *Canscora*. *C. racemosa* differs from *C. diffusa* by presence of trichomes, largest pith region and vascular bundles in 4-angled stem region. By the above circumstance, we suggest this plant has a new species *Canscora racemosa* for the genus *Canscora*. The morphological and anatomical difference between *C. diffusa* and *C. racemosa* were clearly differentiated in table and photo plates.

MATERIALS AND METHODS

The plant specimens for the present study were collected from various parts of South India and the variations among these two plants were studied using fresh materials as well as herbarium specimens. The morphological and anatomical characters were recorded by examining several specimens of each species with the help of stereomicroscope and inverted phase-contrast microscope, respectively. Details about the distribution, habitat, local name and uses were taken from literatures, herbarium specimen data and field observations. Anatomical studies were conducted by hand sectioning and stained with safranin stain and glycerine.

RESULTS AND DISCUSSION

Systematic Studies

***Canscora diffusa*:** Herbs profusely branched; stems winged, green in colour; leaves few; present at the basal portion of the inflorescence; leaves linear-lanceolate; apex acute-acuminate, base flowered; each branch ends with 2-3 flowered; flower always zygomorphic; lobes 4,2+2;

upper 2, equal oblong; lower lobed 2, based elliptic; stamen: anther 3+1 (white and longer orange), Filaments of the upper stamen broadened below the anther, Cymes dense; pedicels not thickened below the calyx; calyx without wings or striations

***Canscora racemosa*:** Herbs sparsely branched; stem not winged at branches, yellow in colour; leaves numerous; present at all the dichotomous stem branches; solitary flowers, petals 2+2-twisted, 2-bilobed; flower zygomorphic or actinomorphic; calyx longer than corolla tube, gynoecium longer than stamens, 3+1 stamens equal in size but 1-highly inserted persistent calyx.

***Canscora diffusa*:** *Canscora diffusa* (Vahl) [6, 10, 12, 15] *Gentiana diffusa* [7]. *Exacum diffusum* (Vahl) [13].

Erect, annual, glabrous herbs, 4–65 cm tall. Stems 4-angular, winged (wings 1-2.5 mm broad) or 4-lineate, simple-diffusely branched. Leaves subsessile-petiolate; petiole 26 mm long; blades of lower leaves broadly ovate or oblong-ovate; upper linear-lanceolate, 15–50 × 5–30 mm, 3–5 nerved; apex acute-acuminate; base attenuate or cuneate. Cymes terminal or axillary, dense, dichasial 3–75-flowered; pedicels not thickened below the calyx, slender, 5–10 mm long; bracts green, lanceolate or broadly ovate, foliaceous or subulate, 1-6 × 0.7-4 mm; texture membranous or mesophytic. Calyx green, slender, without wings or striations, persistent; lobes-4, lanceolate-linear, apex acuminate or acute, 4-5 × 1-1.5 mm. Corolla often rose, rarely white or orange, tubular or funnel shaped; tube 47 mm long; lobes-4, orbicular, 2 upper lobes equal, 2-3 × 2.5-3 mm, lower lobes 3-4 × 1-2 mm, fused at the apex forming a deep slit in which one large stamen is lodged, sometimes with the lobes separated appearing as more or less equal lobes. Stamens 4, anisomorphic (1 large, 3 small); upper stamen filament not broadened below the anther, 1–1.8 mm long; lower stamens filament 0.5–0.9 mm long; upper stamen anther orange, lower yellow-white, linear-oblong. Ovary green, cylindrical, 3–7 × 0.6–0.9 mm; style rose-white, filiform, exserted, 2–4 mm long; stigma bilobed; lobes white, obovate, 0.8–7 × 0.4–7 mm. Capsule brown, oblong-subcylindric, 4–6 × 1–2.5 mm. Seeds irregular, 0.2–0.6 × 0.2–0.35 mm; testa brown, reticulate.

Flowering and Fruiting—June–March.

Habitat:—River banks, grasslands and roadside earth cuttings.

Distribution:—Tropical Africa, Asia and Australia.

Local name:—Jeeraka-pullu (Malayalam).

Uses:—Used as a substitute for *C. decussata* [14].

Canscora diffusa is the most widespread species of the genus in South India and shows considerable variation in habit size (4–65 cm tall), branching pattern (simple-compound diffusely branched), nature of wings (4-lineate or 4-angled-winged) and bracts texture (membraneous or mesophytic). The corollas are often rose, although sometimes might also be white or orange. [1] described *Canscora sanjappae* from the Mookambika Wild life Sanctuary in Karnataka.

Diagnosis: They differentiated their species from *C. diffusa* by its apical branching and regular actinomorphic corolla. [2] Concluded that *C. sanjappae* and *C. diffusa* are synonymous. The branching of stem is neither confined to its apex nor is their flowers actinomorphic. The smaller corolla lobes are fused towards the apex and sometimes are separated, giving the appearance of an actinomorphic corolla, which is common in *C. diffusa*. They found that both zygomorphic and what appear to be ‘actinomorphic flowers’ in the same plant. The length of the stamen also lies within the range of *C. diffusa* [2].

***Canscora racemosa*:** In new species of *Canscora racemosa*, differs by many characters such as raceme inflorescence, slightly bilobed for 2 petals, gynoecium is longer than stamens, persistent corolla, solitary flowers, calyx longer than corolla tube, longer ovary, yellow quadrangular stem and profusely branched stem.

Flowering and Fruiting—December–February.

Habitat:—River banks, grasslands and wetlands.

Distribution:—Asia.

Local name:—Jeeraka-pullu

Uses:—Used as a substitute for *C. diffusa*

Diagnosis: *Canscora racemosa* is closely allied to *C. diffusa* but differs in having limited dichotomous apical branching and branches, farinaceous leaves, much reduction of leaves, pedicellate flowers, lanceolate bracts and two times longer filaments. A more detailed morphological comparison of these two species is given in Table 1.

Diwakar and Singh [1] described *Canscora sanjappae* from the Mookambika Wild life Sanctuary in Karnataka. They differentiated their species from *C. diffusa* by its apical branching and regular actinomorphic corolla. Shahina and Nampy [2] reported that *C. diffusa* shows considerable variation in habit

size (4–65 cm tall), branching pattern (simple-compound diffusely branched), nature of wings (4-lineate or 4-angled-winged) and bracts texture (membraneous or mesophytic). The corollas are often rose, although sometimes might also be white or orange. They reported that the variation between both the species is due to the collections from the type locality and similar specimens from different areas, lead us to the conclusion that *C. sanjappae* and *C. diffusa* are synonymous. The branching of stem is neither confined to its apex nor their flowers are actinomorphic. The smaller corolla lobes are fused towards the apex and sometimes are separated, giving the appearance of an actinomorphic corolla, which is common in *C. diffusa*. They also observed that both zygomorphic and actinomorphic flowers appears in the same plant. The length of the stamen also lies within the range of *C. diffusa*.

In present study on new species *C. racemosa*, we observed variations in their branching type, leaves, inflorescence, anther size, gynoecium size, etc (Table 1). Previous studies on *C. diffusa*, [2] reported that the variations are due to the type locality and similar specimens from different areas. We named the new species *C. racemosa* by raceme type of inflorescence. To confirm the new species *C. racemosa*, anatomical studies were carried between these two species of *Canscora*.

Anatomy of *Canscora racemosa* and *Canscora diffusa* ***Canscora racemosa***

Stem: The anatomy of the stem is irregular round shaped structure with 4-hand like projection from epidermis layer (Fig. 2A). The outermost layered is called epidermis. The epidermis consist of out-growth like structure is known as emergences type of trichomes which is a group of cell arising from the upper most layer of epidermis. The hand like projection is also consisting of finger like projection as trichomes present in the epidermis (Fig. 2B). Each finger like projections has 3 small vascular bundles. The cortex region is second layer of the stem which consists of 4-5 layered parenchymatous membrane. Next to the cortex region is the vascular bundle which consist of single layered parenchyma separate the xylem and phloem from the cortex region. The primary xylem is present towards the pith and secondary xylem towards the periphery. The centre region is the largest region which is fully occupied with large parenchymatous cells. The pith region is usually larger than the vascular bundle in size (Fig. 1A).

Table 1: Taxonomical variation of *C. diffusa* and *C.racemosa*

<i>Canscora diffusa</i>	<i>Canscora racemosa</i>
Stem: Herb, winged, green, profusely branched, strictly ends in 2-3 flowered branch.	Stem: Herb, not winged at branches, yellow stem, sparsely branched, sometimes ends in leaves.
Leaves: few in number usually absent at the base of last inflorescence branch	Leaves: numerous leaves usually occurs upto the end of inflorescence.
Flower: Cyme, usually in clusters, zygomorphic or actinomorphic.	Flower: raceme, usually in solitary flower, zygomorphic or actinomorphic.
Calyx: usually calyx smaller than corolla tube.	Calyx: calyx tube longer than corolla tube.
Corolla: corolla tube longer than calyx tube.	Corolla: corolla tube usually suppressed inside the calyx tube.
Petals: 2+2, 2-larger, 2-smaller and fused. Rose or violet or light pink in colour. Sometimes 4 petals equal in size.	Petals: 2+2, 4-equal in size and shape, Rose or pink in colour. 2-bilobed petals.
Anther: 3+1 anther, usually 3-small, white or orange and 1-longer, orange in colour. Larger anther usually lies in between the fused petals.	Anther: 3+1-equal in size and shape, 1- highly inserted. All anthers are orange in colour.
Filament: larger stamen has longer filament while other 3 anther were same in size and length.	Filament: anther has equal size and shape length filament
Gyneocium: branched stigma, carpel length is smaller than stigma tube. Usually shorter than larger stamen.	Gyneocium: Branched stigma, Carpel length is longer than stigma style. Usually gyneocium is longer than all the 4 stamens.
Fruit: linear, persistent calyx	Fruit: long, cylindrical in shape, strictly persistent calyx.
Seed: shorter, elliptic, irregular in shape.	Seed: longer, elliptic, irregular in shape.

Table 2: Anatomical variation of *Canscora racemosa* and *Canscora diffusa*

<i>Canscora racemosa</i>	<i>Canscora diffusa</i>
Stem	Stem
Stem: Round, 4-winged structure, irregular shape.	Stem: Round, 4-winged, regular in shape.
Epidermis: Outgrowth like trichomes was present in both epidermis and winged structure.	Epidermis: Lack of trichomes.
Pericycle: distinct	Pericycle: not clear distant
Cortex: 3-4 sclerenchymatous layered.	Cortex: 7-9 sclerechymatous layered. Cell were larger in size
Vascular bundle: It is smaller than the pith region.	Vascular bundle: It is largest region in the T.S of stem.
Leaves	Leaves
Epidermis: Trichomes occurs in epidermis.	Epidermis: No Trichomes occurs in epidermis.
Cortex: 5-6 layered parenchymatous cells.	Cortex: 5-6 layered parenchymatous cells.
Stele: protoxylem	Stele: protoxylem
Root	Root
Epidermis: irregular mass of epidermis.	Epidermis: regular single layered epidermis.
Stele: protoxylem, xylem cells are larger than the xylem of <i>C.diffusa</i> .	Stele: protoxylem, xylem cells are smaller than the xylem of <i>C.racemosa</i> .

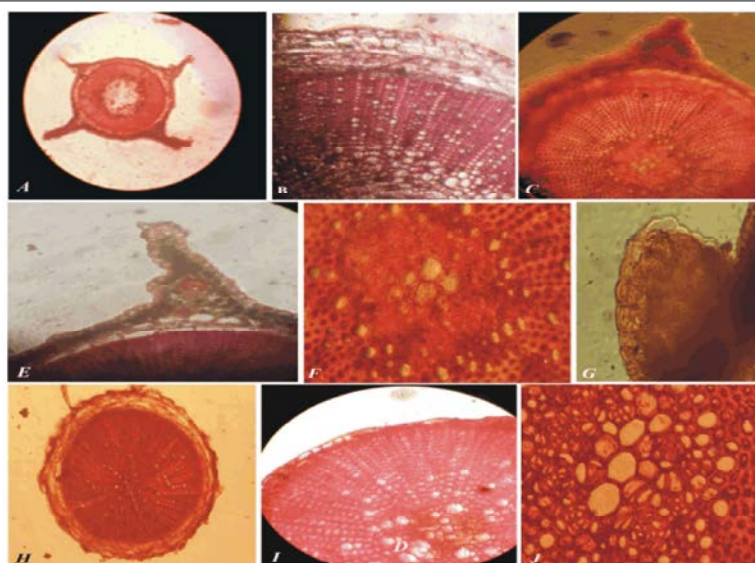


Fig. 1: Anatomical section of *C.diffusa*. (A) T.S of stem, (B) A sectioned enlarged, (C) T.S of stem with winged stem, (E) vascular bundle of winged portion of stem, (F) vascular bundle of Stem, (G) T.S of leaf, (H) T.S of root, (I) A portion enlarged and (J) vascular bundle of root

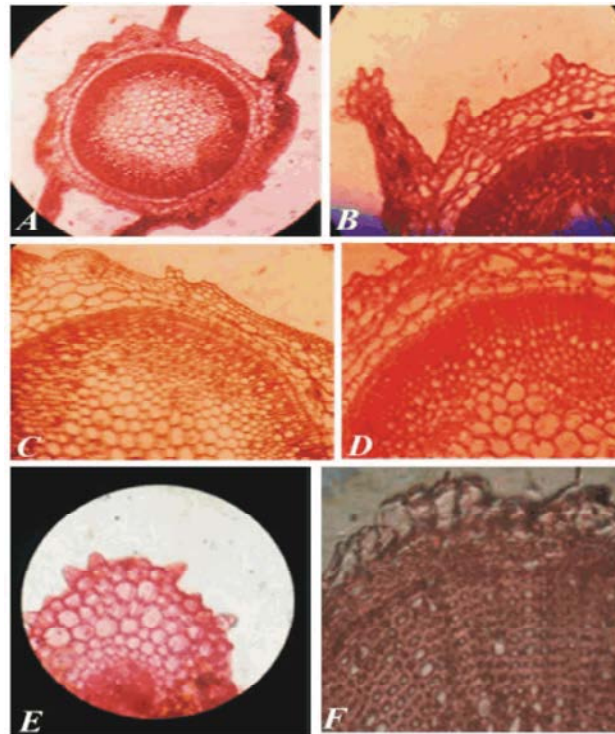


Fig. 2: Anatomical section of *C. racemosa*: (A) T.S of stem; (B) trichomes in epidermis and winged region of stem; (C) vascular bundle of stem with emergence type trichome; (D) enlarged vascular bundle; (E) T.S of leaf and (F) T.S of Root

Leaves: The outermost layer is called as epidermis which is consisting of single layered with spike like trichomes were present (Fig. 2E). Next to the epidermis is 5-6 layered cortex consist of parenchymatous cells. Chlorenchymatous were seen at the both side of leaf region arising. Next to cortex is vascular bundle which separate from cortex by 1-2 layered linear parenchymatous cells.

Root: The outermost layer is called epidermis which consists of irregular mass of single or doubles layered cells. The vascular bundle consists of xylem and phloem in which primary xylem facing towards the periphery and secondary xylem faces towards the pith (Fig. 2F).

C. diffusa

Stem: The T.S of the stem structure is round stem with 4-winged structure. The epidermis consists of single layered with no trichomes or outgrowth (Fig. 1B). The winged structure has single vascular bundle with some chlorenchymatous cell around it (Fig. 1E). The cortex region has 3-4 layered parenchymatous membrane (Fig. 1A and B). Next region to cortex is vascular bundle

which is largest layer of the stem. The primary xylem facing towards the pith and secondary xylem facing towards the periphery (Fig. 1F). The vascular bundle is largest region of the stem. The pith is centre region with parenchymatous cell.

Leaves: The outermost layer is called as epidermis which is consisting of single layered structure with no trichomes (Fig. 1G). Next to the epidermis is 5-6 layered cortex consist of parenchymatous cells. Chlorenchymatous were seen at the both side of leaf region arising. Next to cortex is vascular bundle which separate from cortex by 1-2 layered linear parenchymatous cells.

Root: The outermost layer is called epidermis which consists of single layered cells. The vascular bundle consists of xylem and phloem in which primary xylem facing towards the periphery and secondary xylem faces towards the pith (Fig. 1H-J).

The anatomical study reveals that *C. diffusa* and *C. racemosa* were two different species of the genus *Canscora*. The new species *C. racemosa* differs by the presence of trichomes, limited sclerenchymatous layers and larger pith region (Table 2).

CONCLUSIONS

Shahina and Nampy [2] reported that *C. racemosa* is a variant form of *Canscora diffusa*. In present study, we observed that *C. racemosa* differ from *C. diffusa* by their limited branching and leave numbers, stem, raceme type of inflorescence, size and length of calyx and corolla and longer fruit size. Anatomical studies also confirmed the new species of *C. racemosa* by presence of trichomes, limited sclerenchymatous layer, large pith size, etc. By this, we confirmed that *C. racemosa* is not a variation form of *C. diffusa* and it can be treated as a new species due to the presence of variation in both morphological and anatomical characteristic features.

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REFERENCES

1. Diwakar, P.G. and R. Kr, Singh, 2009. *Canscora sanjappae* (Gentianaceae)-a new species from Mookambika wildlife sanctuary, Karnataka, India. Indian Journal of Forestry, 32(2): 337-342.
2. Shahina, P.M. and Santhosh Nampy, 2014. A taxonomic revision of the genus *Canscora* in South India and the erection of the new genus *Canscorinella* (Canscorinae, Gentianaceae) with two new combinations. Phytotaxa, 164(4): 201-225.
3. Lamarck, J.B.A.P.M. de, 1785. Encyclopedie Methodique Botanique. Panckouck, Paris, 1: 601.
4. Gilg, E., 1895. Gentianaceae In: A. Engler and K. Prantl (eds.) Die Naturlichen Pflanzenfamilien, part 2. Engelmann, Leipzig, 4: 50-108.
5. Linnaeus, C., 1771. Mantissa Plantarum altera generum ed. VI and specierum ed II. Holmiae, pp: 560.
6. Roemer, J.J. and J.A. Schultes, 1827. Mantissa. Vol. 3. Cotta, Stuttgart. A.W. Roth, 1818. *Exacum alatum*. In: J.J. Roemer and J.A. Schultes (eds.), Systema vegetabilium. Vol. 3. Cotta. Stuttgart, pp: 301. Phytotaxa 164 (4) © 2014 Magnolia Press • 225 Revision of *Canscora* in South India.
7. Vahl, M., 1794. Symbolae Botanicae. Moller, Copenhagen, 3: 47.
8. Wallich, N., 1831. A numerical list of dried specimens (Wallich's Catalogue). London.
9. Roxburgh, W., 1820. Flora Indica. Vol. 1. Mission Press, Serampore.
10. Clarke, C.B., 1885. Gentianaceae In: J.D. Hooker, The Flora of British India. L. Reeve, London, 4: 93-132.
11. Clarke, C.B., 1906. Flora of the Malayan Peninsula-Gentianaceae. Journal of Asiatic Society of Bengal, 74: 86-91.
12. Thiv, M., 2003. A taxonomic revision of *Canscora*, *Cracosna*, *Duplipetala*, *Hoppea*, *Microrphium*, *Phyllocyclus* and *Schinziella* (Gentianaceae-Canscorinae). Blumea, 48(1): 1-46.
13. Willdenow, K.L., 1798. Carolia Linne species plantarum; exhibente plantas rite cognitatas ad genera relatas, cum differentiis specificis, nominibus trivlibus, synonymis selectis, locis natalibus, secundum system sexual digestas. Vol. 1, 2. Impensis G.C. Nauk, Berlin.
14. Rama Rao, M., 1914. Flowering plants of Travancore. Government Press, Trivandrum, pp: 269-270.
15. Wight, R., 1850. Illustrations of Indian Botany. Vol. 2. J.B. Pharoah, Madras.